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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/050,570	01/18/2002	Kuniaki Yagi	Q68148	7078

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	6

DATE MAILED: 04/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/050,570	Applicant(s) YAGI ET AL.	
	Examiner Matthew J Song	Art Unit 1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-9 is/are pending in the application.

4a) Of the above claim(s) 6-9 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-5 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-5, drawn to a method, classified in class 117, subclass 84.

II. Claims 6-7, drawn to a product, classified in class 423, subclass 324.

III. Claims 8-9, drawn to a product, classified in class 257, subclass 76.

2. The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, such as a sublimation or sol-gel.

Inventions I and III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, such as a sublimation or sol-gel.

Inventions II and III are related as mutually exclusive species in an intermediate-final product relationship. Distinctness is proven for claims in this relationship if the intermediate

product is useful to make other than the final product (MPEP § 806.04(b), 3rd paragraph), and the species are patentably distinct (MPEP § 806.04(h)). In the instant case, the intermediate product is deemed useful as a source for SiC in a sublimation process and the inventions are deemed patentably distinct since there is nothing on this record to show them to be obvious variants. Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions anticipated by the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Allen Kasper on 3/18/2003 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-5. Affirmation of this election must be made by applicant in replying to this Office action. Claims 6-9 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Claim Objections

5. Claim 1 is objected to because of the following informalities: Claim 1 recites the limitation "the vapor phase growth method" in lines 5-6. There is insufficient antecedent basis for this limitation in the claim. Appropriate correction is required.

6. Claim 1 is objected to because of the following informalities: Claim 1 recites the limitation "the liquid phase growth method" in lines 6. There is insufficient antecedent basis for this limitation in the claim. Appropriate correction is required.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1 and 3-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594).

Kito et al discloses a silicon carbide single crystal layer **15**, this reads on applicant's substrate, and forming a silicon carbide single crystal layer **19a** by a CVD method where, the temperature of silicon carbide layer **15** is increased to be 1500°C and source gases of SiH_4 and C_3H_8 are introduced (col 12, ln 1 to col 13, ln 15). Kito et al also discloses a silicon carbide single crystal ingot **19** is formed on the single crystal layer **19a** by the sublimation-recrystallization method (col 13, ln 15-67), this reads on applicant's depositing SiC by the vapor phase growth method.

Kito et al does not disclose the raw material is supplied in the vicinity of the surface of the substrate and the raw material in the vicinity of the surface of the substrate is given a partial pressure higher at least by a predetermined rate than that of an impurity, thereby suppressing the impurity from reaching the surface of the substrate and preventing the surface of the substrate from being etched by the impurity.

In an improved method of CVD, note entire reference, Cook et al teaches the amount of incorporation of unwanted impurities in CVD films is proportional to the partial pressure of such impurity molecules, this is a teaching that the partial pressure is a result effective variable, and the reduction of impurities in the film produced is due to the reduced partial pressure of impurities in the gas stream above the wafers surface resulting from the increased concentration, this reads on applicant's partial pressure, of the desired reactant species in the gas stream (col 7, ln 65 to col 8, ln 67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kito et al with Cook et al's CVD method of reducing the partial pressure of impurities by increasing the concentration of reactants to reduce the amount of impurities in a film.

Referring to claim 1, the combination of Kito et al and Cook et al is silent to the raw material in the vicinity of the surface of the substrate is given a partial pressure higher at least by a predetermined rate than that of an impurity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al and Cook et al by optimizing the partial pressure rate by conducting routine experimentation of a result effective variable (MPEP 2144.05). The combination of Kito et al and Cook et al is silent to a preventing the surface of the substrate from being etched by the impurity. However, the combination of Kito

et al and Cook et al teaches reducing the partial pressure of the impurities by increasing the concentration of reactants in the gas streams above the wafers surface to reduce impurities, as applicant. Therefore, the etching of the substrate surface is inherently prevented because the combination of Kito et al and Cook et al teach a similar method of reduce the impurity partial pressure, as applicant.

Referring to claim 3, the combination of Kito et al and Cook et al teaches C_3H_8.

Referring to claim 4, the combination of Kito et al and Cook et al teaches SiH_4.

9. Claim 2 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594) as applied to claims 1 and 3-4 above, and further in view of Funato et al (US 5,882,807).

The combination of Kito et al and Cook et al teach all of the limitations of claim 2, as discussed previously, except the temperature elevating step from a first temperature at which etching of the surface of the substrate by the impurity is started to a second temperature not lower than a temperature at which SiC is formed.

In a method of forming Silicon Carbide by Chemical Vapor Deposition (CVD), note entire reference, Funato et al teaches heating a substrate to a temperature of 600-850°C, this reads on applicant's first temperature, and heating at a rate of 50°C/min to a temperature of 1000-1290°C, this reads on applicant's second temperature, and introducing raw material for silicon carbide (col 3, ln 40-67). Funato et al also teaches the possible raw materials are methyltrichlorosilane, methyldichlorosilane or $SiCl_4$ and CH_4 (col 4, ln 1-20). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the

combination of Kito et al and Cook et al with Funato et al's elevating temperature at a rate of 50 °C/min to form a SiC film without pores at a high rate without introducing cracks (col 3, ln 1-40 and col 4, ln 10-55).

Referring to claim 2, the combination of Kito et al, Cook et al and Funato et al teaches a first temperature of 600-850°C. The combination of Kito et al, Cook et al and Funato et al is silent to the first temperature at which etching of the surface of the substrate is started. However, this is inherent to the combination of Kito et al, Cook et al and Funato et al because the combination of Kito et al, Cook et al and Funato et al teaches a similar first temperature of 800°C, as applicant (note pg 15, ln 6-7). Also, the combination of Kito et al, Cook et al and Funato et al is silent to the temperature elevating rate is within a range such that the density and the size of a defect is suppressed to prevent occurrence of a planar defect. The combination of Kito et al, Cook et al and Funato et al teach a heating rate of 50°C/min. This heating rate is inherently within a range such that the density and size of defects is suppressed because the combination of Kito et al, Cook et al and Funato et al teaches a similar rate as applicant (note Fig 3-4 and pg 17, ln 7-9). The combination of Kito et al, Cook et al and Funato et al does not teach the partial pressure of the raw material is adjusted to a level not lower than 100 times that of the impurity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al, Cook et al and Funato et al by optimizing the partial pressure by conducting routine experimentation of a result effective variable (MPEP 2144.05).

Referring to claim 5, the combination of Kito et al, Cook et al and Funato et al teaches the possible raw materials are methyltrichlorosilane, methyldichlorosilane or $SiCl_4$ and CH_4 (col 4, ln 1-20).

10. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kito et al (US 6,110,279) in view of Cook et al (US 6,352,594) as applied to claims 1 and 3-4 above, and further in view of Suzuki (US 5,985,091).

The combination of Kito et al and Cook et al teach all of the limitations of claim 5 including a silane precursor, as discussed previously, except at least one material is selected from the claimed group of materials.

In a method of chemical vapor deposition, note entire reference, Suzuki teaches a material containing Si atoms when a semiconductor thin film of SiC is formed, where silanes such as SiH_4 or organic silanes such as tetramethylsilane ($Si(CH_3)_4$), dimethylsilane, or tetraethylsilane can be used (col 6, ln 15-30). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kito et al and Cook et al with Suzuki's Si containing material as a source because substitution of known equivalents for the same purpose is held to be obvious. (MPEP 2144.06).

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Larkin et al (US 5,709,745) teaches controlling the concentration of the crystal growing components in a growth chamber, thereby controlling impurity incorporation into the growth sites (Abstract).

Shoimi et al (US 2001/0000864) teaches a SiC deposition using a solid source Si resulting in the partial pressure of hydrogen in the atmosphere to decrease, thereby eliminating the problem of etching [0018].

Shoimi et al (EP 0933450) is equivalent to US 2001/0000864.

Hamakawa et al (US 5,021,103) teaches a hydrogen dilution rate in a mixture gas for forming Silicon carbide is equal to the partial pressure of hydrogen divided by the sum of the partial pressures of carbon containing species and silicon containing species (col 3-4).

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700

Matthew J Song
Examiner
Art Unit 1765

MJS
April 17, 2003